U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 669

FIBER FLAX

FIBER FLAX was grown in North America from the earliest colonial times until homespun linens were displaced by mill-manufactured cottons, between 1820 and 1850.

In the development of American agriculture to large-scale production fiber flax, for which there were no efficient machines to replace hand labor, could not compete with other crops. No fine linens are manufactured in this country, and most of the 5,000 to 8,000 tons of flax fiber used annually in the American mills for making shoe thread, sewing thread, twines, and toweling is imported.

This country offers the best market in the world for linen goods. The importations of manufactured linens have increased in value from about $20,000,000 annually in pre-war years to more than $50,000,000 in 1924.

Conditions of soil and climate are favorable for the cultivation of fiber flax in the northern part of the United States where there is sufficient rainfall, and with labor-saving machinery and improved methods for harvesting, threshing, retting, and scutching this crop is now competing successfully with other crops in limited areas in Michigan and Oregon.

Washington, D. C.

Issued May, 1915
Revised September, 1925

FIBER FLAX

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INTRODUCTION

THE PURPOSE of this bulletin is to discuss the production of flax for fiber, yet it must not be understood that the seed is lost in growing fiber flax. In the course of the work conducted by the Office of Fiber Investigations it has been found that many persons believed it impossible to produce a high grade of flax fiber without sacrificing the seed. This belief, however, has repeatedly been shown to be a misconception. It is true that the variety of flax commonly grown in the Northwest for seed production will not, under present methods, yield a fiber suitable for spinning purposes. It is also true that the yield of seed from fiber flax usually is lower than that from flax grown primarily for seed, yet the quantity of seed produced is sufficient to constitute a valuable by-product.

In all countries except Ireland where fiber flax is grown commercially the general practice is to save the seed. In Belgium, where the highest quality of fiber is produced, seed from the best types of flax is used for sowing and the remainder saved for feeding. In Russia the seed obtained is used for sowing, and in addition great quantities are exported for seed purposes. In Holland the seed is not only saved but is highly prized for sowing. The characteristic climatic conditions in Ireland are such that the seed does not mature uniformly, and growers believe that the value of the seed which does mature is not sufficient to pay the cost of threshing.

WORLD'S PRODUCTION OF FIBER FLAX

The total production of flax fiber in 1924 is estimated at about 460,000 tons, compared with 340,000 tons in 1923, and still less in 1921 and 1922. The present production is a little more than one-

half that of pre-war years. Russia, including the Baltic Provinces, now Esthonia, Latvia, Lithuania, and Poland, formerly produced more than 80 per cent of the world's supply of flax fiber. The production in these countries, which had fallen off, especially in Soviet Russia, is gradually increasing. Complete statistics are not available, but it is estimated that these countries produced nearly 70 per cent of the fiber-flax crop of 1924. The leading flax-fiber producing countries in the order of production are Russia, Poland, Belgium, Lithuania, Latvia, Czechoslovakia, Esthonia, Netherlands, Japan, and Ireland. About 7,000 acres were devoted to fiber flax in the United States in 1924, while more than 3,000,000 acres were sown to seed flax.

DISTRIBUTION OF FLAX SPINDLES

Data obtained by the International Federation of Flax and Tow Spinners' Association in regard to the location of the flax spindles of the world in 1914 are shown in Table 1.

TABLE 1.—*Location of the flax-spinning factories of the world in 1914*

Countries	Number of spindles	Countries	Number of spindles
United Kingdom	1,161,874	Italy	20,000
France	567,079	Sweden	18,158
Russia	367,207	United States	8,612
Belgium	315,404		
Austria-Hungary	296,833	Total	3,034,101
Germany	278,934		

Nearly one million spindles, or about one-third of the total number, are in Ireland. Irish linens are well known throughout this country, yet it is not generally known here that Ireland imports about three-fourths of the flax fiber used in the manufacture of these linens. Though France ranks second in number of spindles, the manufacturers there find it necessary to import about four-fifths of the fiber which is used. The industry has not become stabilized since the war, but since 1914 there has been a marked increase in the number of spindles in Japan, and since 1919 a marked decrease in those in operation in the United Kingdom.

IMPORTATIONS OF FLAX FIBER AND LINENS

The spinning mills of the United States have been importing flax fiber for many years, and importations of materials manufactured from flax have been steadily increasing. The people of the United States are great users of linen, as evidenced by the fact that the value of the goods imported each year is more than $40,000,000. The quantities of fiber and of linens imported annually are shown in Tables 2 and 3.

More than half the linens exported from Ireland are sent to the United States, and the statistics show that fully three-fourths of our linen imports are received from that country.

TABLE 2.—*Average annual imports into the United States of flax fiber in 5-year periods from 1881 to 1920 and annual imports for the years 1921 to 1924, inclusive*

Years	Quantity	Value	Import price per ton [1]	Years	Quantity	Value	Import price per ton [1]
	Tons				*Tons*		
1881–1885	5,655	$1,542,069	$272.69	1911–1915	9,123	$3,028,607	$331.97
1886–1890	6,866	1,911,888	278.46	1916–1920	5,335	4,281,707	675.88
1891–1895	6,485	1,779,246	274.36	1921	3,932	2,229,097	566.91
1896–1900	7,198	1,569,759	218.08	1922	5,775	3,320,804	575.03
1901–1905	8,203	2,161,188	263.46	1923	7,420	3,792,270	511.08
1906–1910	9,909	2,634,882	265.91	1924	3,889	2,003,593	515.19

[1] The import price of the fiber per ton is the average of all grades, including dressed line, scutched flax, ow of flax, etc. These were the declared values at the point of export and not the prices at which the fiber could be purchased in the United States.

TABLE 3.—*Annual imports into the United States of linen goods* [1] *for the fiscal years from 1904 to 1913, inclusive, and the calendar years from 1919 to 1924, inclusive*

Year	Value	Year	Value
1904	$18,012,042	1912	$26,381,970
1905	17,930,367	1913	28,208,884
1906	21,382,886	1919	19,603,315
1907	23,783,323	1920	51,983,488
1908	19,693,823	1921	29,313,701
1909	20,245,595	1922	40,256,636
1910	27,423,896	1923	42,328,512
1911	24,632,505	1924	51,175,872

[1] The figures in this table, compiled from statistics published by the Department of Commerce, include woven linens, linen handkerchiefs, linen embroideries and laces, but not linen yarns, which will more than offset the value of cotton in some of the goods made partly of cotton yarns.

CONDITIONS IN THE UNITED STATES FAVORABLE FOR FIBER-FLAX PRODUCTION

During the past years a number of statements have been made to the effect that flax fiber of good quality could not be produced in this country. Doubtless some of these statements were occasioned by failures of attempts to obtain fiber suitable for spinning purposes from the threshed straw of the flax commonly grown in the Northwest for seed or oil production. In this connection it should be understood that flax grown for fiber is a variety distinct from that grown primarily for seed production. (See fig. 1.) Furthermore, it has been established that in order to produce fiber flax of good quality greater care is essential in the selection and especially in the preparation of the soil and in the selection and grading of seed than is commonly practiced in growing flax for oil.

In 1895 fiber flax of excellent quality was grown experimentally in the Puget Sound region. At the request of a representative from one of the Irish mills a quantity of this flax straw was sent to Ireland for retting and preparing according to their methods. The report of the firm conducting the work stated that the fiber obtained in the test compared very favorably with that produced in the famous flax region of Courtrai, Belgium.

Fiber flax of good quality has been grown repeatedly in Minnesota, Wisconsin, and Michigan on a scale sufficient to demonstrate that

it can be successfully done. In eastern Michigan and in Oregon it is now being grown commercially.

These various demonstrations indicate rather clearly that the soil and climatic conditions in certain sections of the United States are favorable for growing fiber flax provided the proper cultural methods are employed. The areas in which climatic conditions are most favorable for growing fiber flax are shown on the accompanying map (fig. 2).

FIG. 1.—A fiber-flax plant (on the left), showing the characteristic tall stalk and few seed boils, and a plant of seed flax (on the right), with shorter stalks and many seed bolls

CLIMATIC RELATIONS

Fiber flax can best be grown in regions where moderately cool damp weather prevails during the summer. Under favorable soil conditions the plants respond to a humid atmosphere and a relatively low and uniform temperature during a long growing season by developing tall stalks with fiber of good quality. In localities where, during the season of growth, the temperature frequently rises to high points and the soil becomes very dry, the crop matures earlier and the plants are much shorter.

Sufficient moisture is needed to enable the plants to continue, without interruption, their growth during the period of elongation of the stems. Under certain conditions the soils of some regions might be capable of retaining moisture sufficient to meet the requirements of the plants throughout this period, but in nearly all cases rainfall is needed during this time. It is desirable that there should be little or no rainfall during the ripening period and harvesting time.

The weather records show that conditions of temperature and humidity of the principal flax-growing centers of Europe are very nearly the same as those which prevail in certain sections of New York, Michigan, Wisconsin, Minnesota, Oregon, and Washington. There are other localities in the United States where the climate is suitable for growing flax for fiber, but the States mentioned are cited because fiber flax of good quality has been grown there.

SOIL RELATIONS

The soils on which fiber flax is to be planted should be of such a nature that good drainage is afforded, as the plants will not endure

severe inundation. At the same time the soil should have a good water-retaining capacity. A gently sloping field having a loam soil with a clay subsoil is suitable, provided it is in a good state of fertility and is free from weeds.

Fiber flax has been grown on muck soils and also on light sandy soils, with varying success. When grown upon muck the experience generally has been that the plants attained a good height, but the quality of the fiber was not equal to that of fiber produced on upland. When grown upon sandy soils the difficulty is that the crop is too dependent upon frequent rainfall for the necessary moisture, since there is so little available water stored in such a soil.

The land selected for fiber flax should be of good fertility. In Ireland the Department of Agriculture and Technical Instruction has found that the addition of some available form of potash to the soil has given profitable results in a series of experiments extending

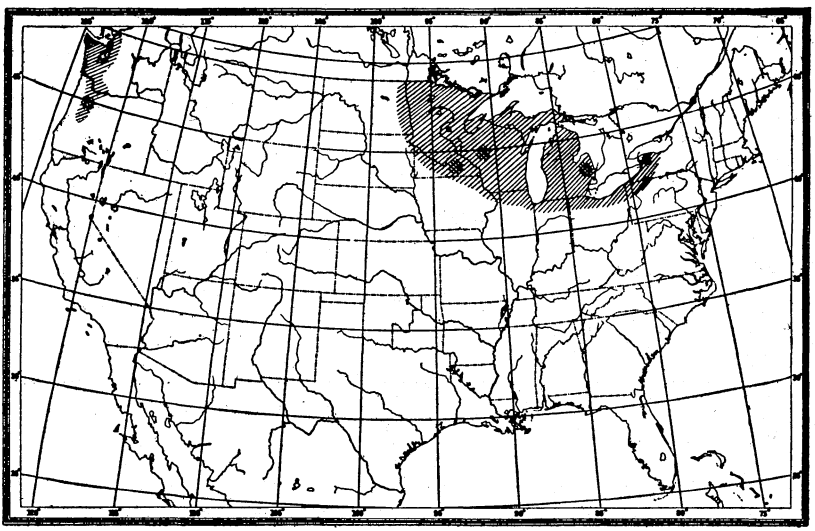

FIG. 2.—Map of the United States, showing by crossed lines the areas where fiber flax has been grown in recent years and by single lines areas having climatic conditions favorable for its production

through several years, and it is recommending this practice to the Irish growers. It would be difficult to recommend a practice of fertilization which would be applicable to all sections where fiber flax can be grown, as the solution of this problem is governed very largely by local conditions. Many flax growers apply barnyard manure to the soil at some period of the rotation. If this practice is followed, it is advisable that the manure be applied to a crop preceding flax, because if applied directly the flax is likely to be uneven, and quantities of weed seeds are nearly always introduced with stable or barnyard manure. Moreover, it is not advisable to use barnyard manure when flax straw has been used as bedding for the animals, since in this way the soil may become infected with flax diseases which live over in the old straw. If manure having flax straw or chaff in it is to be utilized for fertilizing land intended for flax, it should be thoroughly composted before being applied.

It has often been asserted that flax depletes the soil fertility to a greater extent than the other agricultural crops, and no doubt many of these assertions were based upon observation. If a farmer noted a diminished yield in the crop immediately following flax, he might conclude that the flax had required an extraordinary quantity of plant food. This conclusion, however, was based on apparent results, since the real cause of the diminished yields may not have been understood.

It has been found upon investigation that an average crop of flax removes less plant food from the soil than does a crop of corn or oats. Flax plants have delicate root systems which occupy only the upper few inches of the soil, whereas the plants of oats and corn have more vigorous root systems which may penetrate the subsoil. Hence oats and corn may obtain from the subsoil a portion of the food materials essential for plant development, but flax plants necessarily must obtain practically their entire nourishment from the upper few inches of surface soil which the roots occupy. Undoubtedly then more of the available plant food in the upper 5 or 6 inches of soil is removed by flax than by the deeper rooted crops. Therefore, in preparing flax stubble for the succeeding crop care should be taken to plow deep enough to bring up some of the subsoil in order to replenish the surface soil with available plant food.

PREPARATION OF THE SEED BED

Too much emphasis can not be placed upon the necessity of a thorough preparation of the seed bed, for upon this more than upon any other cultural factor will depend the success or failure of fiber-flax production. It is indeed futile to attempt to produce a fine quality of fiber unless one is willing to expend the utmost effort in preparing the soil for seeding. Additional time and effort spent in putting the land in the best possible condition will be repaid (1) by a more uniform growth of plants, resulting in a more uniform quality of fiber, and (2) by greater ease in harvesting.

If a clover field or other sod is to be prepared for fiber flax, the field should be plowed in the fall. If flax follows a cultivated crop, spring plowing usually is satisfactory. Numerous dead furrows are to be avoided, as the flax which grows therein is short and difficult to harvest. A few days prior to seeding, the land should be double disked or cultivated with a spring-tooth harrow. In either case it is preferable to work the field diagonally. The peg-tooth harrow should be used as many times as may be necessary to render the soil very fine and to leave the surface smooth. A firm seed bed is very desirable, and in order to obtain this it is often advisable to use a roller. The land is not ready for seeding until it has been reduced to a fine and compact condition.

SEED AND SEEDING

Fiber flax and seed flax belong to the same botanical species (*Linum usitatissimum* L.), but, like sweet corn and field corn, they are of different types. Seed of fiber flax must be sown in order to produce fiber-flax plants. Fiber-flax seed is not handled by seedsmen in this country and may be purchased only from growers or

imported from Europe. Practically all fiber flax may be traced to a Russian origin within the past 20 years. Growers of fiber flax in the United States and Ontario have imported seed from Europe, either directly from Riga or from Holland or Belgium, where seed of recent importation from Riga has been grown. Flax from this imported seed deteriorates after three or four years of growth in this country, and fresh supplies of seed have been imported, always with a risk of importing flax diseases.

The results thus far obtained in experiments conducted by the Office of Fiber-Plant Investigations seem to indicate that these frequent importations of seed are unnecessary provided proper attention is given to a seed plat. It is recommended that a portion of the field be set apart for producing seed. All weeds should be pulled from this plat, and the crop should not be harvested until the seed is fully matured. The grower can afford to sacrifice the quality of

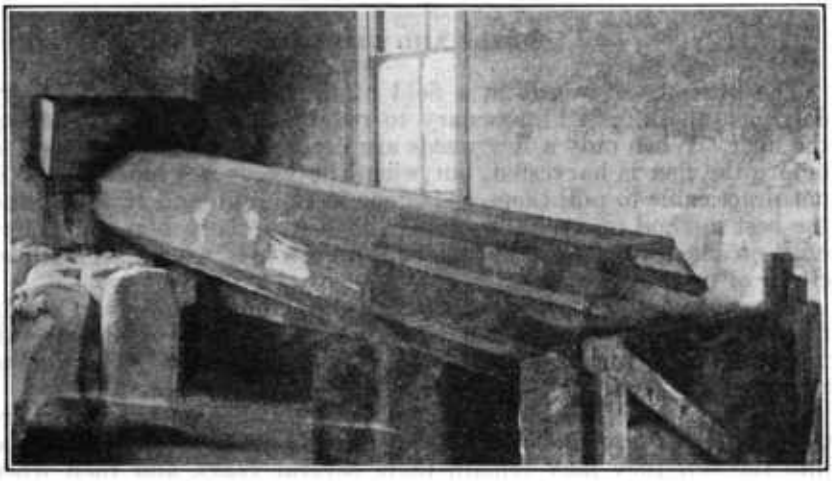

FIG. 3.—A homemade seed grader. The octagonal frame is covered with sieves of increasing coarseness, first permitting the dust and fine seeds to fall through; second, the small flax seeds of marketable grade; and, third, the plump, large seeds for sowing, while the twigs and coarse material pass out at the end

the fiber from the seed plat in order to obtain plump, well-matured seed for his general crop the next season.

The seed should be passed through a fanning mill or a seed grader of such a nature that all dirt, chaff, weed seeds, and light, immature seed will be eliminated. A homemade seed grader which has done satisfactory work is shown in Figure 3. Only the heavy, well-matured seed should be selected for planting.

Fiber flax should be sown as early in the spring as is practicable after the danger of freezing weather is past. The experience of flax growers in eastern Michigan and in Oregon shows that the best quality of fiber is obtained from early-planted flax.

The seed should be drilled or sown broadcast. A double-disk drill covering the seed at a uniform depth in rows 5 to 7 inches apart gives good results, provided it is adjusted so as not to cover the seed too deeply. Toothed drills, single-disk drills, or drills with one series

of disks behind and alternating with those in front give less satisfactory results, because they plant the seed too deeply or do not cover it uniformly.

If broadcasted, the seed should be covered about half an inch deep. This can be done with a very light peg-tooth harrow with the teeth set well back.

The experience of successful fiber-flax growers in this country has shown that seed should be sown at the rate of 5 to 7 pecks per acre. Six pecks per acre on well-prepared soil has given the most uniform satisfaction. When smaller quantities of seed are planted, the tendency of the stalks is to branch and become coarse, with a poorer quality of fiber. When greater quantities of seed are planted the stalks usually are very fine and uniform, but in case of rain accompanied by heavy wind near harvest time there is danger that the plants will go down, and once lodged it is nearly impossible for such thickly planted flax to regain an upright position.

WEEDS AND DISEASES

The presence of weeds in a field of flax grown for fiber is very detrimental, since it is necessary to remove them before preparing the fiber. When only a few weeds are present they should be pulled before the flax is harvested, but when the weeds are numerous it is not practicable to pull them, as is done in Belgium and Holland, and the best method of avoiding trouble with them is to plant fiber flax only on clean soil. There will be fewer weeds when flax follows clover or other sod or hemp.

The weeds which are most likely to be troublesome are Canada thistle, lambs-quarters, pigeon grass, wild buckwheat, smartweed, morning-glory, pigweed, flax dodder, and some forms belonging to the mustard family.

The diseases which thus far have been most destructive to flax are those which are capable of living in the soil. After being introduced into the soil they may remain there several years, and then when flax is planted they may severely injure and in some cases destroy the crop. Flax wilt is one of these diseases which often does much damage.

The results of experiments conducted by Prof. H. L. Bolley, of the North Dakota Agricultural Experiment Station, indicate that flax growers may avoid introducing these disease organisms into the soil (1) by using thoroughly cleaned and graded seed and (2) by not applying barnyard manure which contains flax straw or chaff to land intended for flax. Moreover, since the organisms may live in the soil for several years, it is advisable not to plant flax on the same field more frequently than once in seven or eight years.

HARVESTING

In order to secure the best quality of fiber, flax should be harvested before the seed is fully mature. Under average conditions the harvesting time is about 80 days after planting, though this period may vary from 70 to 100 days, according to season. Extremely hot and dry weather will shorten the growing period, whereas cool damp weather tends to lengthen it. When the lower parts of the stalks are

turning yellowish and the lower leaves are beginning to drop, the flax should be harvested.

The usual method of harvesting fiber flax in European countries is by hand pulling, and this method has also been used in certain sections of the United States where laborers could be hired at reasonable rates (fig. 4). Marked improvements in the efficiency of flax-pulling machines have been made in recent years, and the expensive back-aching work of hand pulling is being superseded by machine pulling.

When flax is cut a varying quantity of fiber is left in the stubble, and when put in the shock the cut ends of the straw are in direct contact with the soil, and fiber in the lower portion of the stalk may become badly discolored or otherwise injured. These

FIG. 4.—Pulling fiber flax

disadvantages, however, are offset to a considerable extent by the diminished cost of harvesting. Moreover, when proper attention has been given to the preparation of the seed bed the surface of the field will be smooth and even, so that the flax may be cut very close to the ground.

Self-rake reapers, mowing machines with tables back of the cutting bars, and grain binders have been used for cutting flax. When either of the first two machines is used, it is necessary to bind the bundles by hand; and in case the mowing machine with the table back of the cutting bar is used two men are required to operate it, one to drive the team and attend to the machine and one to rake the bundles off the table.

At the present time the grower receives $5 to $10 more per ton for pulled flax than for cut flax, and there is, of course, a larger quantity

per acre when the crop is pulled. Since the cost of hand pulling ranges from $15 to $20 per acre, the advantage gained by pulling is questionable from the grower's viewpoint unless efficient pulling machines are available.

Fields of poor crops, short or tangled so as to be unfit for the production of spinning fiber, are cut with mowing machines, raked up with hay rakes, and without retting put through a series of fluted rollers, threshing the seed and softening the straw for upholstering tow.

After the flax is harvested the bundles should be set up in small shocks to allow uniform drying. (See fig. 5.)

YIELD

The yield of fiber flax is often expressed by giving the weight of harvested and cured straw before threshing. This weight varies

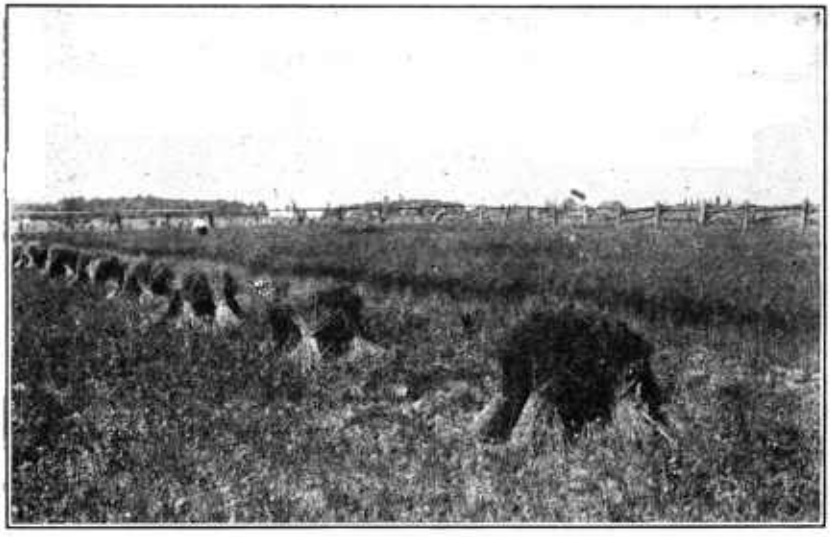

FIG. 5.—A field of fiber flax at harvest time. The bundles of pulled flax are set in small shocks to cure

from 1 to 3½ tons per acre, though the average crop is from 1½ to 2½ tons. The quantity of seed which is borne on the straw varies from 3 to 12 bushels per acre, the average being from 4 to 7 bushels.

The yield of fiber will depend upon the care given to the preparation of the seed bed, the quality and quantity of seed sown per acre, the method of harvesting and of threshing, and the manner of removing the fiber, as well as upon the available moisture and fertility of the soil. A yield of 770 pounds of clean retted fiber per acre has been obtained in eastern Michigan, though the average yield there is from 300 to 450 pounds per acre.

Breeding work, with the aim of developing long-stemmed varieties that will yield more and better fiber, has been carried on by the Bureau of Plant Industry since 1909, and more recently it has been taken up in Ireland, Holland, and Sweden. Strains of decided

superiority have been developed, and efforts are being made to increase the seed for commercial sowing. A long-stemmed uniform variety gives an increased yield to the acre, permits cutting with a lower percentage of waste in the stubble, reduces the cost of handling for the unit of weight, stacks easier and better, rets more uniformly because of the uniform diameter of the stalks, and produces longer and more uniform fiber.

MARKET

The market has been a very important factor in limiting the production of fiber flax in this country. Under present conditions it is advisable for the grower to sell the flax straw with the seed on it to a flax dealer. The farmer is thus relieved of the retting and breaking processes.

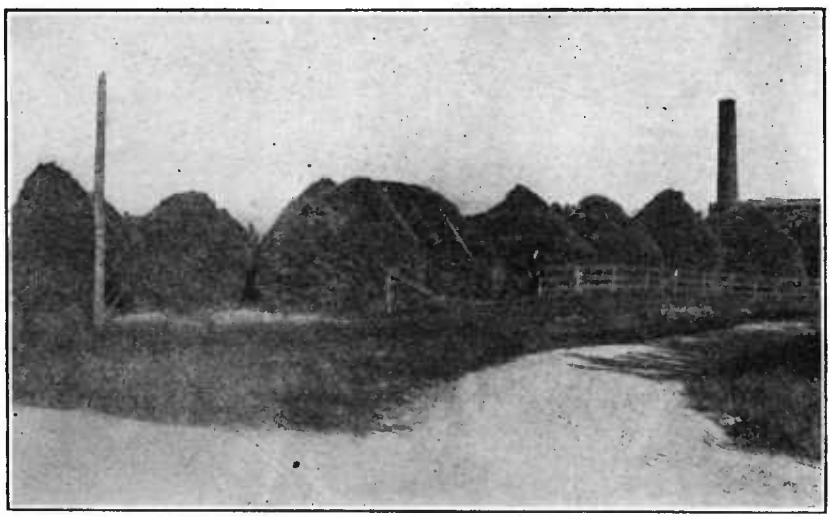

FIG. 6.—Stacks of pulled fiber flax grown in eastern Michigan in 1914. Sometimes flax stacks are thatched, in order to better protect them until the fiber can be prepared

The practice in eastern Michigan is for fiber flax to be grown under contract. The farmer purchases the seed from the flax dealer and furnishes the land and labor required to produce the crop. After harvest he delivers the cured flax straw to the dealer at the mill for a price usually agreed upon at planting time. The flax dealer stores the straw in warehouses or in stacks (fig. 6) until he can thresh it and prepare the fiber. The prices paid to the farmer during the past three years have varied from $20 to $35 per ton, depending upon the condition of the straw and also upon whether the flax was cut or pulled.

PREPARATION OF THE FIBER

The preparation of spinning fiber from flax straw is a process involving skilled labor and special machinery. These conditions render it impracticable for the individual flax grower to undertake

it, though it might be practicable for a number of growers to do so by cooperation. An association of growers could secure the services of an experienced man who would superintend the various processes.

THRESHING

The first operation after the flax is harvested and cured is to remove the seed. A method should be employed whereby the seed bolls may be crushed or stripped off without breaking, doubling, or otherwise injuring the straw.

The common practice in this country has been to pass the head ends of the bundles between two wide pulleys held together by springs. (See fig. 7.) The mixture of seed and chaff thus obtained is passed between two rollers located just above the hopper of a fanning mill. The rollers crush any seed bolls in the mixture, and the fanning mill separates the seed from the dirt and chaff.

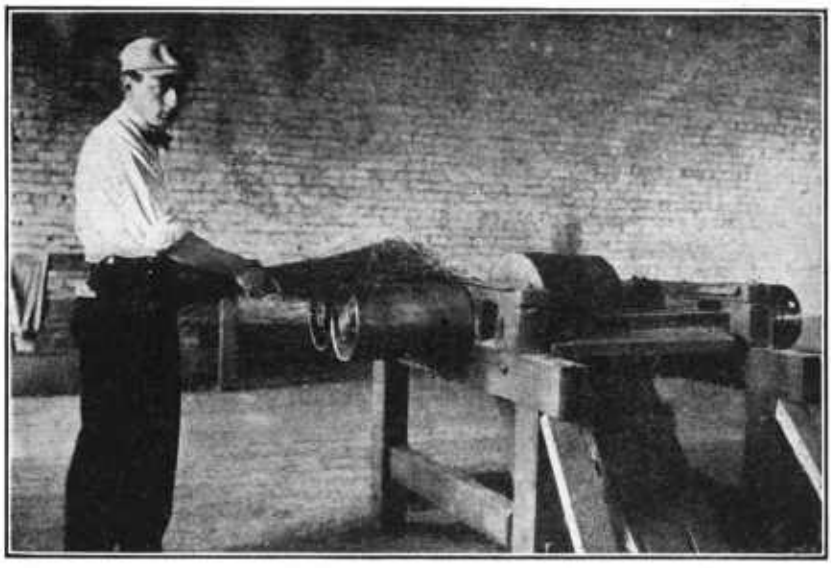

FIG. 7.—Machine for threshing fiber flax. The seed end of the bundle is passed two or three times between the wide pulleys, which revolve toward each other and are pressed together by springs

A combined machine for threshing fiber flax and cleaning the seed has been in successful operation in Ontario since 1922. This machine is about as large as a grain threshing machine and requires about the same power. The flax straw, fed sidewise in a continuous layer, is grasped by broad belts carrying the heads past a series of rollers which crush the seed bolls. The carrying belts continue through the machine, delivering the straw to an automatic binder which binds it into bundles. The clean seed is delivered on one side of the machine and the chaff is blown out at the opposite side.

RETTING

The retting of flax consists of a treatment which will loosen the fiber from the woody portion of the stalk so that it may be readily

removed. There are two principal methods of retting, viz, dew retting and water retting. The process is of such a nature that an inexperienced person should not attempt it unless there is some one to superintend the work who does understand it. This statement holds for both retting methods, yet it applies especially to water retting.

Dew retting is the method employed in many of the flax-growing provinces of Russia and has been used in this country to a greater extent than the other methods. It consists of spreading the threshed straw in straight rows on a field, preferably a meadow, and allowing the action of rain, dew, or snow to remove the gummy materials which cause the fiber to adhere to the woody portion of the stalks. (See fig. 8.) This takes place in two to eight weeks, depending upon the climatic conditions. The straw is sometimes turned once during the retting process.

FIG. 8.—Flax straw spread for dew retting. Most of the fiber flax grown in the United States has been dew retted

The best flax fiber is obtained from the Courtrai region of Belgium, where flax is water retted in the River Lys. Flax is also water retted in Ireland and in certain provinces in Russia, but in these countries the retting is done in pools or reservoirs. The bundles of flax are usually placed upright in crates, or nets, and are immersed by placing weights on top of the whole. As fermentation progresses it is generally necessary to add more weights in order to keep the straw under water. The retting process is usually completed in from 6 to 15 days, depending upon the condition of the water. The straw should be removed at just the proper time, as a few hours' delay often causes loss. The practice in Belgium and in some portions of Ireland is to watch constantly during the latter part of the retting period in order to remove the straw from the water at the time when the retting process has progressed sufficiently, even though this be during the night. The straw is set on end to drain for about 24 hours and is

then spread over a meadow for a few days in order to become thoroughly dry. After drying the straw is stored until time for breaking and scutching.

Nearly all the flax in Oregon is water retted in tanks. Water is supplied from a small stream, and the tanks are equipped with steam pipes to control the temperature. The water is drawn off before the bundles are removed, and arrangements are made to avoid as much as possible the disagreeable work of handling the wet straw.

Hot-water retting has been tried in recent years, especially in Belgium. Special types of tanks are used in which the water is heated to about 100° F. This method rets the flax more rapidly than the normal temperature of 65° to 75° F., and it produces fiber of good color, but the fiber is rather harsh and does not meet the approval of spinners.

All water retting depends on the action of bacteria, not one species alone, but several species. Some of these are always present unless the straw and water have been sterilized, and it would be practically impossible to maintain pure cultures in commercial retting tanks. The development of the most desirable forms may be encouraged by keeping the temperature within certain limits.

Some soap solutions and certain coal-oil derivatives produce a retting effect on flax straw, but the numerous efforts to use them for this purpose have not resulted in producing fiber satisfactory to the spinner.

Artificially drying water-retted straw has been practiced to a limited extent, but the straw must not be heated enough to drive off the oil and produce a harsh fiber.

BREAKING, SCUTCHING, AND HACKLING

One type of machine which is in general use for breaking flax straw is shown in Figure 9. Very often the rollers of each succeeding pair have smaller corrugations and fit closer together than those of the one just preceding. The dry retted straw is fed endwise between the fluted rollers, and the woody portions of the stalks are broken into small pieces, while the fiber, being tough and elastic, remains unbroken.

The breaking process reduces the woody portion to short, small pieces, called shives, but removes only a small percentage of it. The shives are removed by scutching. The common method of doing this is by subjecting the broken straw, a handful at a time, to the beating action of a wheel with paddles radiating from its center. Combined breaking and scutching machines are coming into use, thus reducing the hand labor.

USES

There are about a dozen flax-spinning mills in the United States, most of them in Massachusetts, New York, and New Jersey. Flax fiber is used in these mills in the manufacture of sewing thread, shoe thread, harness thread, fishlines, fish nets, and twines. Toweling, linen crash, and fire hose are woven from flax yarns. No fine

linen yarns are spun in this country, and the mills are not equipped with either the machinery or skilled flax spinners necessary to spin the yarns. There is abundant opportunity, however, for an enlarged market for American flax fiber for present uses, provided the fiber is well prepared so as to be of a quality equal to that imported from Europe.

SUMMARY

The cultivation of flax for fiber and the cultivation of flax for seed or oil are two distinct industries. Fiber flax is a variety distinct from seed flax.

Fiber flax yields both spinning fiber and seed suitable for oil production.

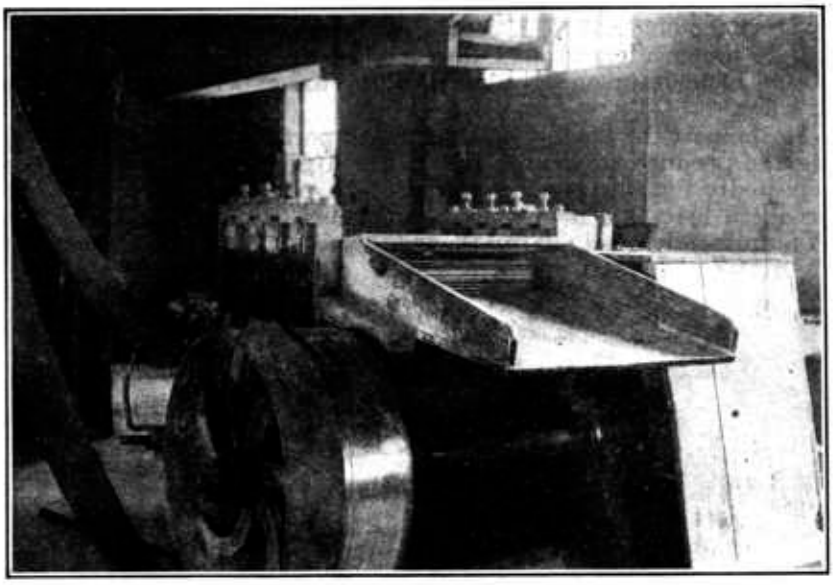

FIG. 9.—A flax brake. The woody portion of the retted flax straw is broken by passing the straw between the fluted iron rollers

The straw of seed flax grown in the Northwest does not yield a fiber suitable for spinning.

Before the World War Russia produced about four-fifths of the world's supply of flax fiber.

About one-third of the flax spindles in the world are in Ireland.

The United States imports annually about $3,000,000 worth of flax fiber and more than $40,000,000 worth of linen goods.

The climatic and soil conditions in various sections of the United States are favorable for growing fiber flax. A relatively low temperature and sufficient moisture during the growing season are desirable. In general, a loam soil with a clay subsoil is to be recommended.

The preparation of the seed bed is one of the most important factors in the culture of fiber flax. Sod should be fall plowed. The seed bed should be rendered fine and compact before seeding.

The seed should be thoroughly cleaned and graded. It should be drilled or broadcasted at the rate of about 6 pecks per acre and should be covered not more than half an inch deep.

Fiber flax should not be sown on soil infested with weeds, since the weeds would have to be removed at some time before the fiber could be spun.

Flax diseases live in the soil a number of years; consequently, it is not advisable that flax be planted on the same field more frequently than once in seven or eight years.

Pulled flax is of greater value for fiber than cut flax. The practice of pulling is recommended if practicable means of doing it are available.

An average yield of fiber flax in this country is about 2 tons of unthreshed straw per acre, from which 4 to 7 bushels of seed and 300 to 450 pounds of clean retted fiber may be obtained.

The preparation of flax fiber requires technical knowledge and should be undertaken only by those who are experienced in that line of work.

In the past the market has been an important factor in discouraging the production of fiber flax in the United States. It has been repeatedly demonstrated, however, that excellent flax fiber can be produced here, and it is hoped that it may be produced in quantity of a uniformly good quality that will meet the approval of spinners.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

July 17, 1926

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1926